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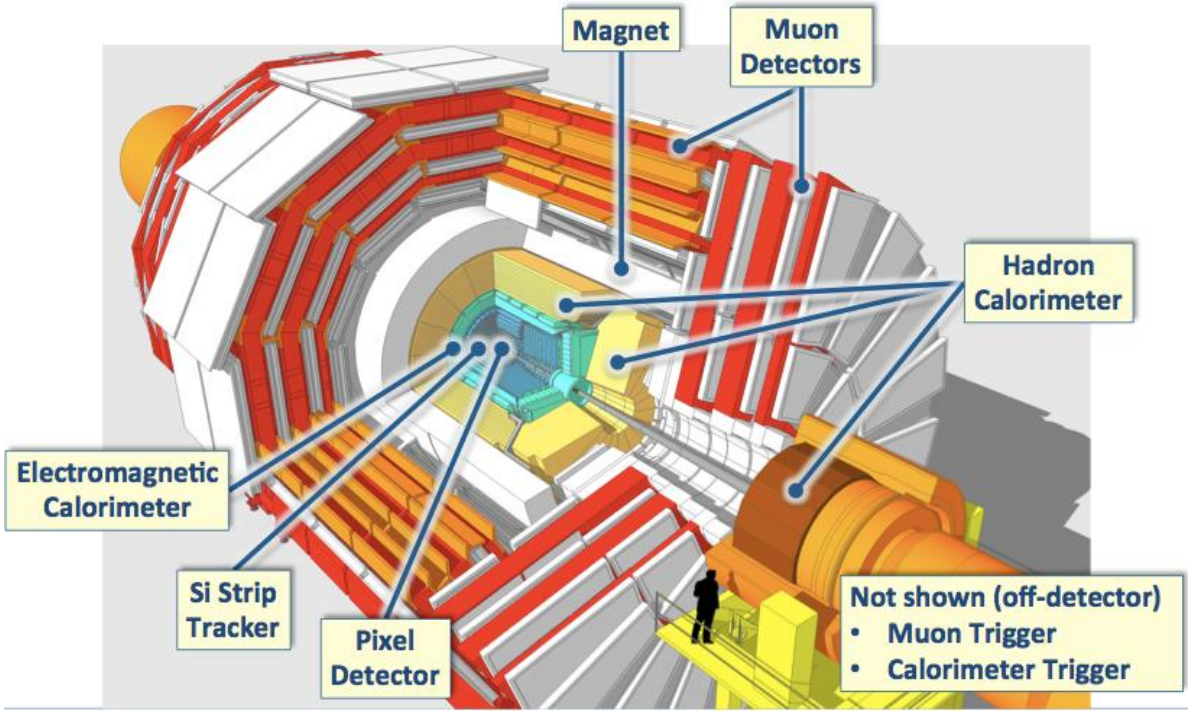
CD-2/3 IPR

LHC CMS Detector Upgrade Project



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Federal Project Director
9/5/2014

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Outline

- Purpose and Scope
- Work Breakdown Structure
- Key Performance Parameters
- Project Management Organization
- Schedule
- Cost and Funding
- CD-2/3 Prerequisites
- FPD Concerns
- Conclusions

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Purpose and Scope

Purpose:

- Install detector upgrades during operational shutdown in 2018
- Enable CMS to exploit the physics opportunities afforded by these machine upgrades
- Provide at least 3 to 4 years of operation at much higher luminosity than original CMS design

Project Scope:

- Hadron Calorimeter (HCAL): Replacement of hybrid-photodiode detectors in the Barrel and Endcap with silicon photomultipliers, readout electronics to increase bandwidth, off-detector electronics for higher bandwidth and improved trigger information
- Forward Pixel detector (FPIX): Two endcap pixel detectors, each consisting of modules of 100 mm x 150 mm pixels, organized into 6 half-disks, housed in 2 half-cylinders
- Trigger (TRIG): Layer-1 of the upgrade Calorimeter Trigger, Endcap Muon Trigger

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Work Breakdown Structure

WBS#	WBS NAME
401	Large Hadron Collider (LHC) Compact Muon Solenoid (CMS) Detector Upgrade Project
401.01	Project Management
401.01.01	Project Milestones and Interfaces
401.01.02	Project Management and Administration
401.01.03	Project Controls and Finance
401.01.04	Project Office Support
401.02	Hadron Calorimeter (HCAL)
401.02.01	HCAL Milestones and Interfaces
401.02.02	HCAL Management
401.02.03	HF Frontend
401.02.04	HB/HE Frontend
401.02.05	HCAL Backend
401.03	Forward Pixel Detector (FPIX)
401.03.01	FPIX Milestones and Interfaces
401.03.02	FPIX Management
401.03.03	FPIX Components
401.03.04	FPIX Assembly and Testing
401.03.05	FPIX Pilot System
401.04	Trigger
401.04.01	Trigger Milestones and Interfaces
401.04.02	Trigger Management
401.04.03	Muon Trigger
401.04.04	Calorimeter Trigger

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Key Performance Parameters

HCAL

Threshold KPP- defined to de-couple from CERN LHC Shutdown schedule

- Produce HCAL Front and Back end Electronics
- Install Back End electronics and connect to Calorimeter Trigger
- Test stand integration of HCAL electronics to demonstrate readiness for install

Objective KPP- Complete installation only if Shutdown schedule allows

- Complete installation and checkout of HCAL Front End electronics in the CMS Detector
- Integration of the HCAL Back End electronics with the CMS data acquisition system

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Key Performance Parameters(Cont.)

FPIX

Threshold KPP- Not dependent on CERN shutdown schedule

- Produce 4 half cylinders, each with 3 half disks
- Demonstrate read out in test stand at CERN
- Turn over to CMS Technical Coordination

Objective KPP

- Produce components for a spare half disk

Key Performance Parameters(Cont.)

Trigger

Threshold KPP- defined to meet physics objective

- Install Layer 1 of upgrade calorimeter and muon trigger
- Demonstrate 98% agreement between installed upgraded electronics at CERN and trigger emulation using test data patterns
- Factor of 2 reduction trigger rates for electrons, photons, muons, and taus from current system
- Less than 15% efficiency loss from current system
- Incorporate additional CSC chamber data into muon trigger logic

Objective KPP- improves possible reach of physics objective

- 99.5% agreement between installed upgraded electronics at CERN and trigger emulation using test data patterns
- Less than 10% efficiency loss to the present system

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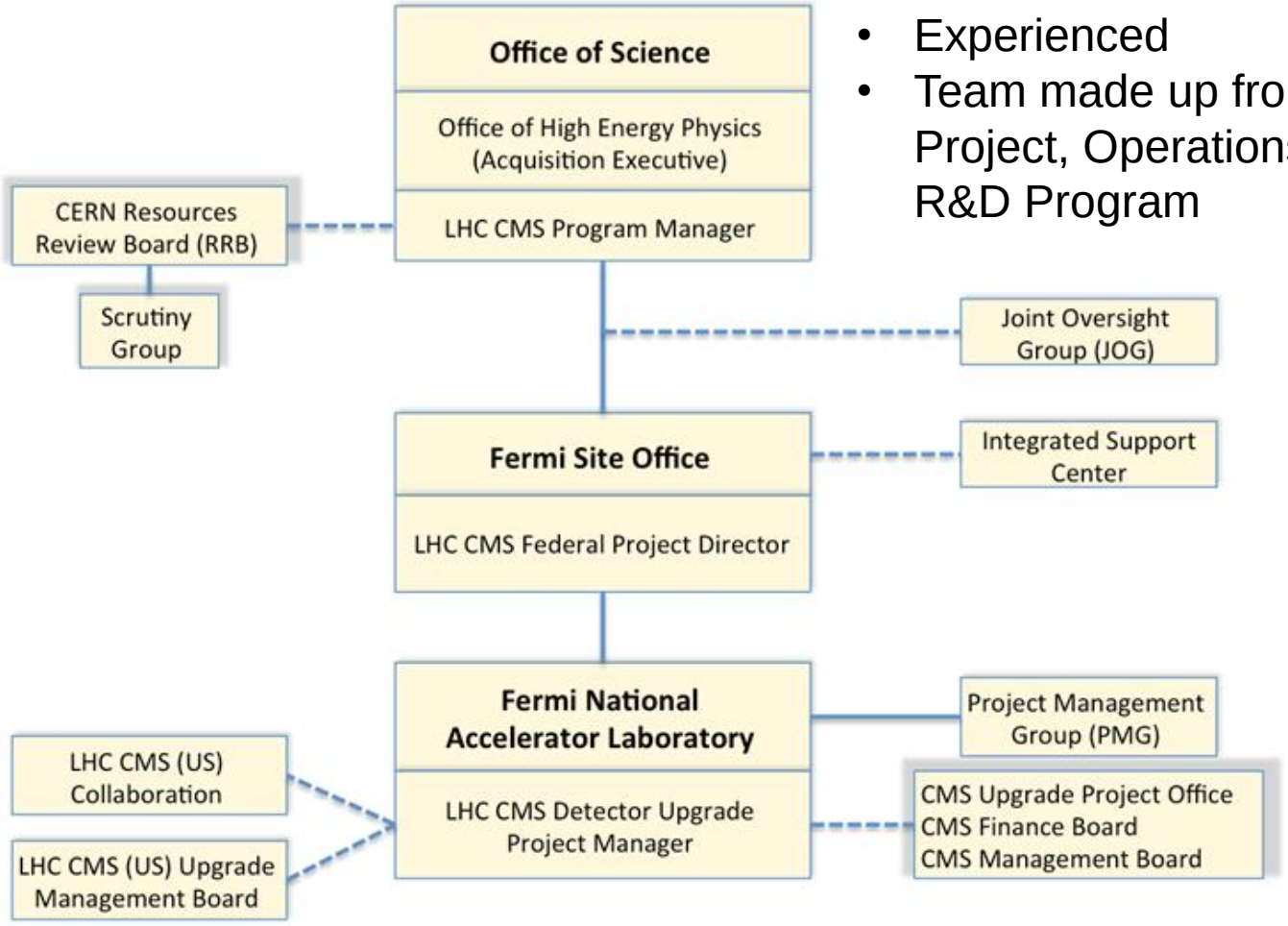
Project Mgmt Organization



- Experienced
- Team made up from original CMS Project, Operations, and Upgrade R&D Program

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Proposed CD Schedule

Level 1 Milestone	Schedule
CD-0 Approve Mission Need	**9/18/2012 (actual)**
CD-1 Approve Alternative Selection and Cost Range	**17/10/2013 (actual)**
CD-2 Approve Performance Baseline	**4th Qtr FY14**
CD-3 Approve Start of Construction	**4th Qtr FY14**
CD-4 Approve Project Completion (defined as delivery of components)	**1st Qtr FY20**

Milestone	Typical Float
CD-4	16 months
Level 2 milestones—Federal Project Director	6 months
Level 3 milestones—Project Manager	3 months

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Cost and Funding

WBS #	WBS Title	Total $K
401.01	Project Management	2,717
401.02	Hadron Calorimeter (HCAL)	5,398
401.03	Forward Pixel Detector (FPIX)	3,126
401.04	Trigger	3,013
	Direct TEC	14,254
	TEC Contingency	5,121
	TEC	19,375
	Design and Prototyping	11,965
	Direct OPC	11,965
	OPC Contingency	2,240
	OPC	14,205
	TPC	33,580

Note: This is the cost data as of July 17, 2014. As the contingency is consumed, the PMB will change. The change to the PMB is not defined as a major change requiring a PEP update.

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Cost and Funding

Fiscal Year	FY 12	FY 13	FY 14	FY 15	FY 16	FY 17	FY 18	Total ($M)
OPC*		1.5	6.25	2.5				7.5
Design		1.5	6.25					
TEC**				5.0	9.5	8.5		25.75
Total Project Cost*** ($M)		1.5	6.25	7.5	9.5	8.5	0	33.25

Contingency on Work Remaining is 33%
NSF contribution of $11.5M is not shown

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CD-2/3 Prerequisites

- ✓ Preliminary/Final Design—completed
- ✓ Acquisition Strategy—completed
- ✓ Project Execution Plan—completed
- ✓ Resource Loaded Schedule—completed
- ✓ Performance Baseline—completed
- ✓ Earned Value Managment System—in place
- ✓ Environmental Documents and Permits—completed
- ✓ Quality Assurance Program—in place
- ✓ Hazard Analysis Report—completed
- ✓ NEPA Documentation Issued—completed

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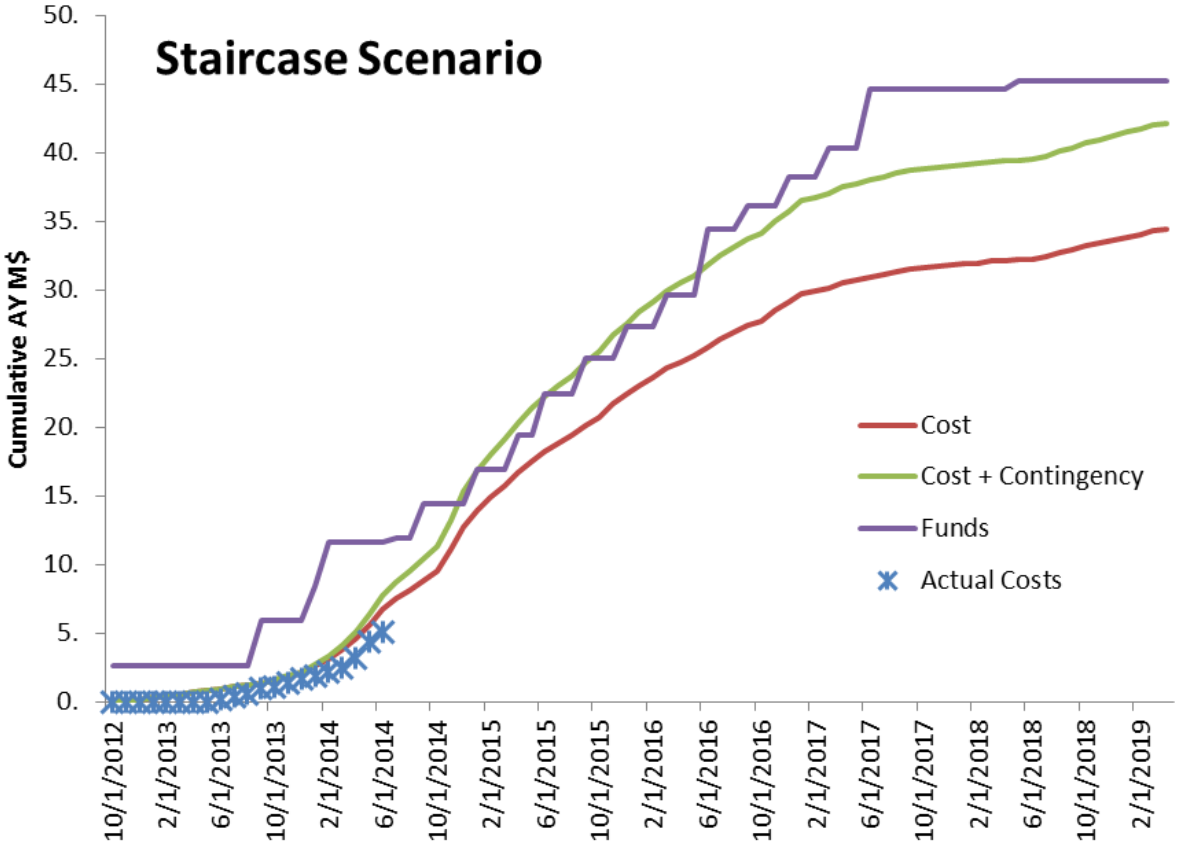
FPD Concerns



FY15 Funding

- Funding and Projected Cost are tight
- Projection does not take into account possible continuing resolution

Projects response

- Currently de-obligating funds for additional carryover
- Pursuing changing some FY15 MIE funds to OPC
- Worked an agreement with CERN for $3M in forward funding through their Team Accounts

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FPD Concerns

Project controls & EVMS

- Project has had problems retaining a project controls specialist
- CAM readiness and knowledge on EVMS was lacking early in the project
- Problems with the Lab's Cobra systems prevented EVMS data from being evaluated

Projects Response

- Project got a project controls specialist from NoVA, he brings experience from that project
- Several training sessions were started for CAMs
- The Project kept a record of the needed EVM data to enter into the Lab systems when they became operational
- Project team has developed a greater understanding and appreciation for EVM

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Conclusion

Recommend CD-2/3 Approval

- CD-2/3 prerequisites met
- Project well defined
- Good management team in place
- A “mini”-review addressing EVMS was conducted to re-evaluate the project, the reviewers were please with the progress made in a short amount of time